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FACILITY FORM 602

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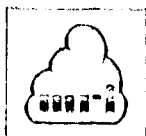
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FINAL REPORT
CRYSTAL PRESSURE TRANSDUCER
CONTRACT NO. NAS 4-701

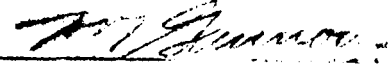
Submitted to

National Aeronautics and Space Administration
Flight Research Center
Edwards, California

By

Meteorology Research, Inc.
2420 North Lake Avenue
Altadena, California

March, 1965

Approved: 
M. T. Gannon
Director of Engineering

MRI65 FR-227

I INTRODUCTION

This report is submitted in accordance with the requirements of Contract No. NAS 4-701. It covers Phase II and the completion of the program.

This final report provides two categories of information. First, in the conduct of Phase II, MRI found that the design indicated in the Phase I Report could and should be improved. These changes and the resultant improvements will be indicated. Secondly, certain information concerning the components of the breadboard system is furnished to help simplify future tests and evaluations of the approach.

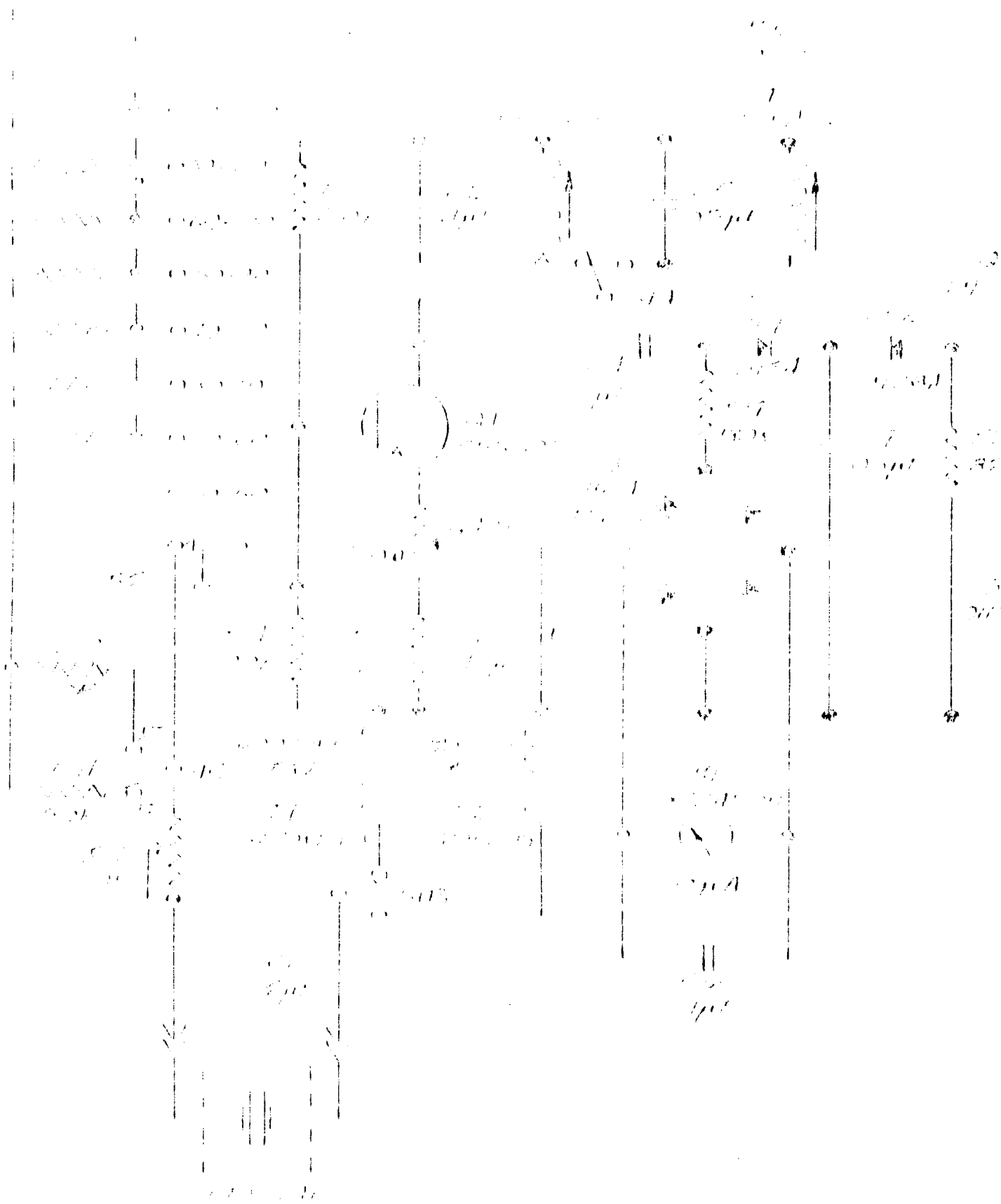
In the course of construction and checkout of the breadboard, it was found that both types of transducer exhibit a change in characteristic as a function of the gas pressure. This change is in the predicted direction and appears to be more pronounced in the JT transducer than in the NT unit. Further establishment of the relationship between the transducer changes and the gas density as well as an indication of the minimum density measurement capability of this technique requires the more complete testing on the part of FRC.

II THE BREADBOARD SYSTEM

In the course of operational tests of the breadboard indicated by the Phase I Report, it was found that the crystal driving circuit which appeared satisfactory for the JT type transducer was not compatible with the NT element. The higher Q of the NT crystal demands a stability beyond the basic capability of the tuned circuit coupled multi-vibrator which had proven reasonably successful for the JT element.

The problem of obtaining a suitably stable driving source for both transducers was discussed with the crystal fabricators. From these discussions, it was concluded that a separate driving oscillator would be impractical even though "matched crystals" were used. No practical way was found to alter the frequency of the driving oscillator crystal to follow those changes in the frequency of the transducer induced by the gas density changes. The next logical step was to find a means whereby the transducer itself becomes the frequency determining element. This to provide a system that can "track" automatically in frequency over the operating range of the transducer.

A form of blocking oscillator circuit was designed with a tuned collector circuit inductively coupled to the emitter circuit and with feedback through the transducer element. The schematic for this circuit is shown in Drawing B10709. By maintaining a standard output at meter M2 and using a decade series of resistors in conjunction with the multiple turn potentiometer R12, the change in equivalent resistance of the transducer can be monitored over a wide range.



REVISIONS

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MAR 23 1965

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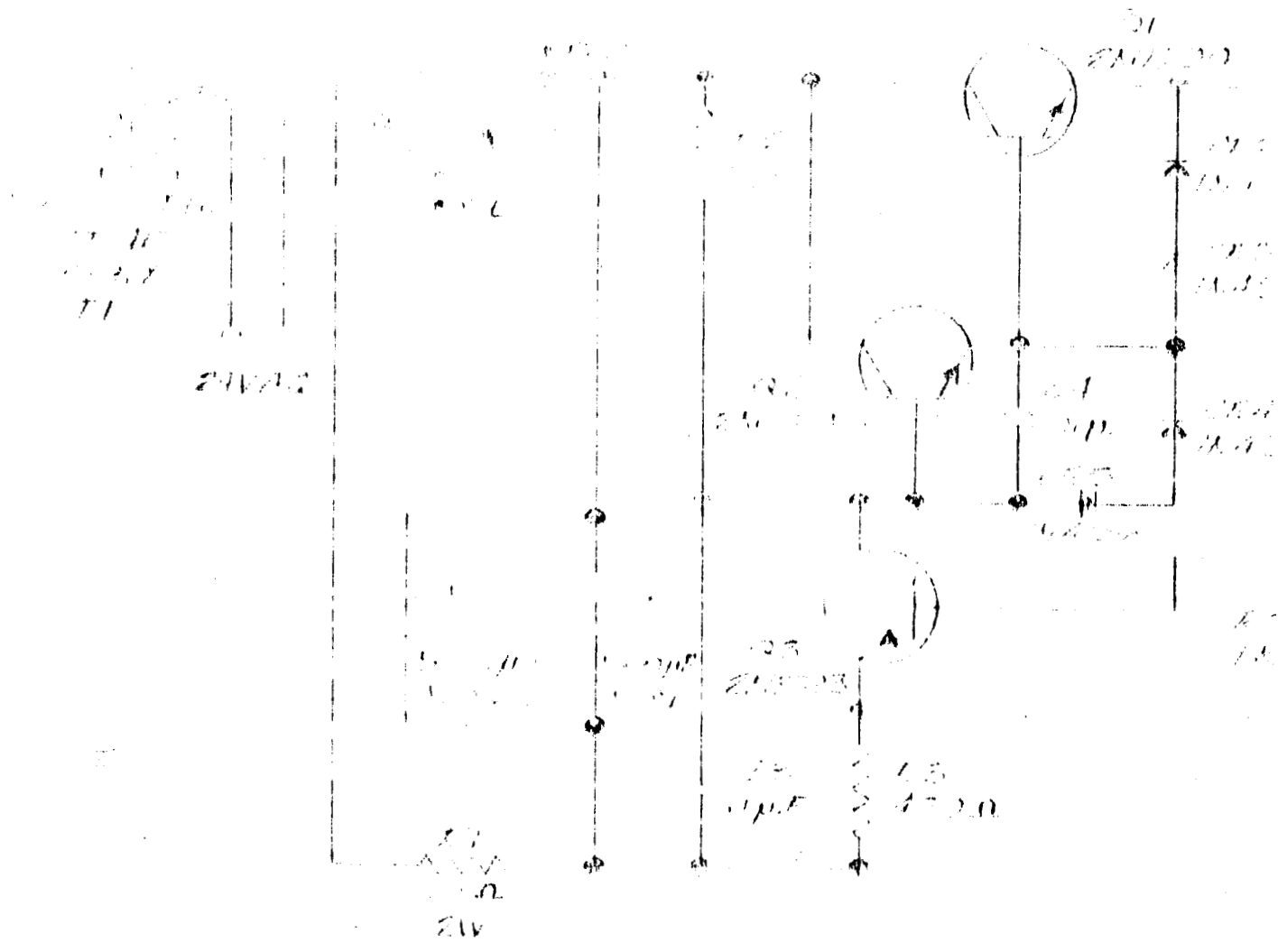
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This measurement circuit is adapted to usage on a standard 60 cycle power source by means of a regulated power supply. The schematic diagram for this power supply is shown in Drawing B10669. For operation of this system, this power supply is adjusted for a regulated output of 14 volts DC.



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XX .01	
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altadena, calif.

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FIGURE

SIZE

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A

SCALE

WT

SHEET

III TRANSDUCER SOURCES

During Phase I of the program, a number of quartz crystal fabricators were contacted in order to find a suitable supplier for the transducers involved. Most such organizations were found to be interested primarily in furnishing standard catalog crystals and did not have engineering departments that would permit special transducer work of the type required for this program. Two organizations did, however, indicate an interest in working on this problem. They were:

1. Monitor Products Company, Inc.
815 Fremont Avenue
South Pasadena, California

Attn: Mr. Don Montgomery
Chief Engineer

2. Northern Engineering Laboratory
357 Beloit Street
Burlington, Wisconsin

Attn: Mr. John D. Holmbeck
President

Since it appeared that the competence of these two organizations was approximately equal, Monitor Products was selected purely on the basis of their proximity.

As delivery of the required transducers appeared to pace our ability to deliver the breadboard to FRC, some freedom as to the frequency of the two types of transducers was exercised. This was particularly critical in the case of the JT unit since fabricating the laminated duplex blanks is somewhat lengthy and involves a high mortality rate. Monitor was requested to furnish three

transducers of the same frequency and of the JT type in the frequency range from 1.000 to 2.000 kilocycles. Because of crystal blank availability, they selected 1.600 kilocycles and these units were ordered and furnished to FRC with the breadboard system.

In the case of the NT crystals, Monitor was requested to furnish three units at the same frequency in the range from 10.00 to 20.00 kilocycles. Because of element availability, they selected 16.384 kilocycles and these units were furnished with the breadboard system.

A copy of the catalog of crystal products furnished by Monitor is enclosed as Appendix to this report. In addition, we have included a copy of the purchase order which MRI used to obtain the transducers from this organization.

THIS ORDER NUMBER MUST APPEAR
ON ALL PACKAGES, INVOICES AND
SHIPPING PAPERS

meteorology research, inc.

2420 n. lake ave.
sycamore 1-1286altadena, calif.
murray 1-5742

PURCHASE ORDER NO. 10540-229

DATE 12-10-64

SHIP TO

Monitor Products Co., Inc.,
815 Fremont Avenue
TO South Pasadena, Calif.

SHIP VIA

☐ CONFIRMING TO: John W. BlasierTAXABLE ☐ NON-TAXABLE ☒ AP 88884

F. O. B.

TERMS

DELIVERY DATE

Need 12-18-64

QUANTITY	DESCRIPTION	PRICE	AMOUNT
ea	Type JT Crystals @ 1600 c.p.m.		
ea	Type NT Crystals @ 16.384 Kc.		

RECEIVED

Order completed

By

DEC 14 1964

Issued to

REQ. BY

M.T. Gannon

NO.

229

W.W.O. NO.

9370

DATE REQUIRED 12-18-64

APPROVED

PRINTED BY GRAYARD CO., INC., BROOKLYN 22, N. Y.

AUTHORIZED SIGNATURE

AGT.

IV FUTURE CONSIDERATIONS

If it can be determined that this transducer will respond over the density range of interest, an extension of the breadboard equipment furnished could be used to establish a prototype approach for a measuring instrument. With the changes that were made in the breadboard circuit during Phase II, the problem of the frequency tracking between the driving source and the transducer seems to have been solved. The remaining problem in practical instrument design appears to be the maintenance of a standard output level and the automatic adjustment of the ratio of decade resistance to transducer radiation resistance as changes occur throughout the gas density range. It would appear feasible to accomplish both of these tasks by servo techniques such that a readout directly in gas density could be obtained on a continuous basis and without operator attention.

Our rather superficial measurements of the breadboard prior to delivery to FRC indicate that the JT element may offer the highest probability of measurement over the density region of interest. Theoretical considerations also indicate that the JT unit will be more sensitive than other types at the low gas density. However, in the event that this form of transducer does not exhibit suitable sensitivity for the FRC requirement, consideration should be given to techniques that will enhance the low density sensitivity. Among such techniques is the possibility of placing this transducer in a contoured chamber of such dimensions that the gas volume is reduced to the minimum consistent with eliminating mechanical interference at the maximum amplitude of vibration. This should increase both the reactive and dissipative components of the radiation resistance and may extend useful range of measurement further into the low density region.